Fig. 1

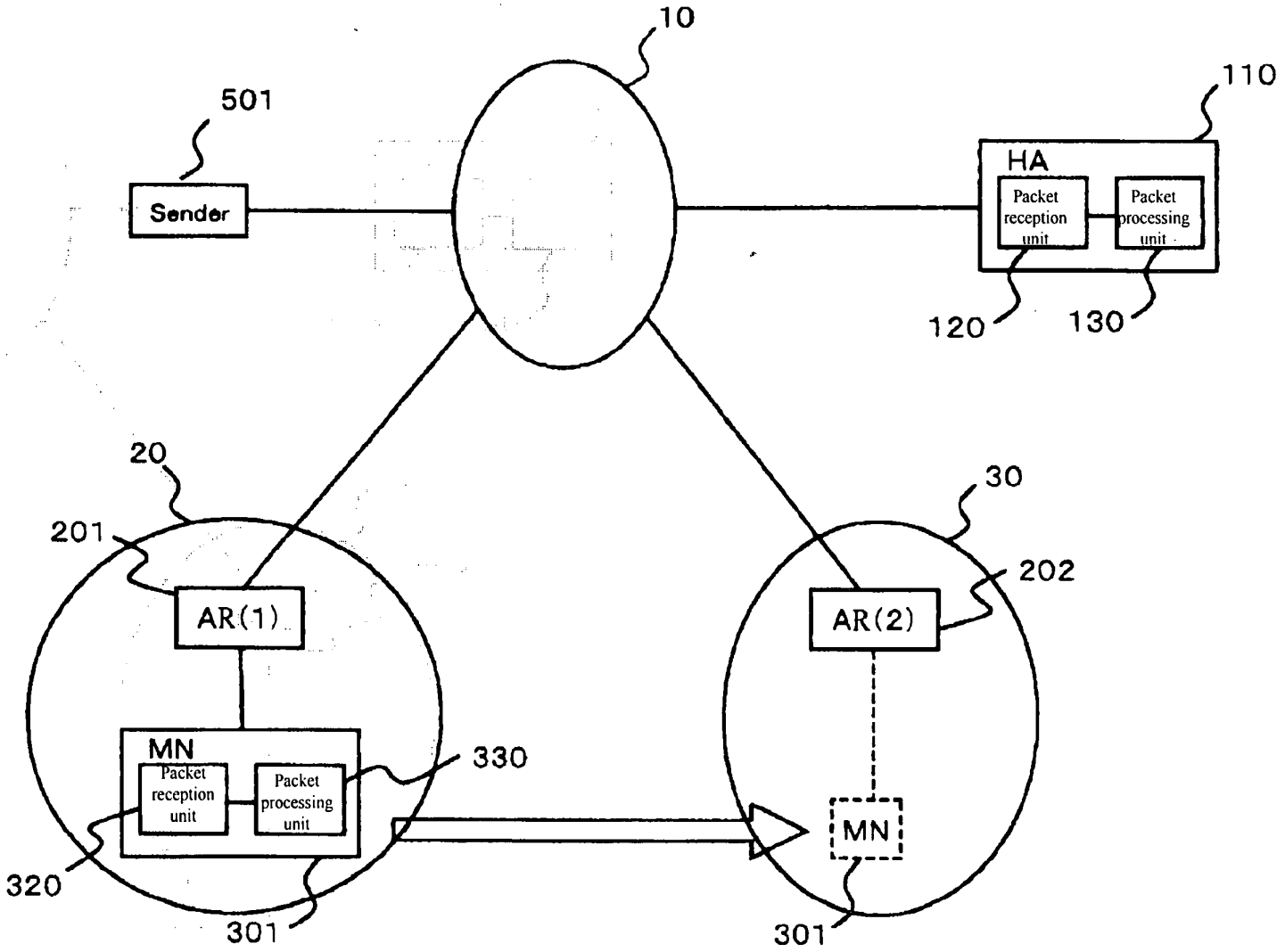

10
501
Sender
110
HA
Packet reception unit
Packet processing unit
120
130
20
201
AR(1)
30
202
AR(2)
MN
Packet reception unit
Packet processing unit
330
320
301
MN
301

Fig. 2

Multicast group	Foreign subnetwork	Direct forwarding packet arrival time period
A	SN(1)	2sec
A	SN(2)	1
A	SN(3)	4
A	SN(4)	3
B	SN(1)	1
B	SN(2)	2
B	SN(5)	3
B	SN(6)	3
~	~	~
G	SN(m)	2
G	SN(n)	1
G	SN(k)	4
G	SN(j)	99
~	~	~

Fig. 3

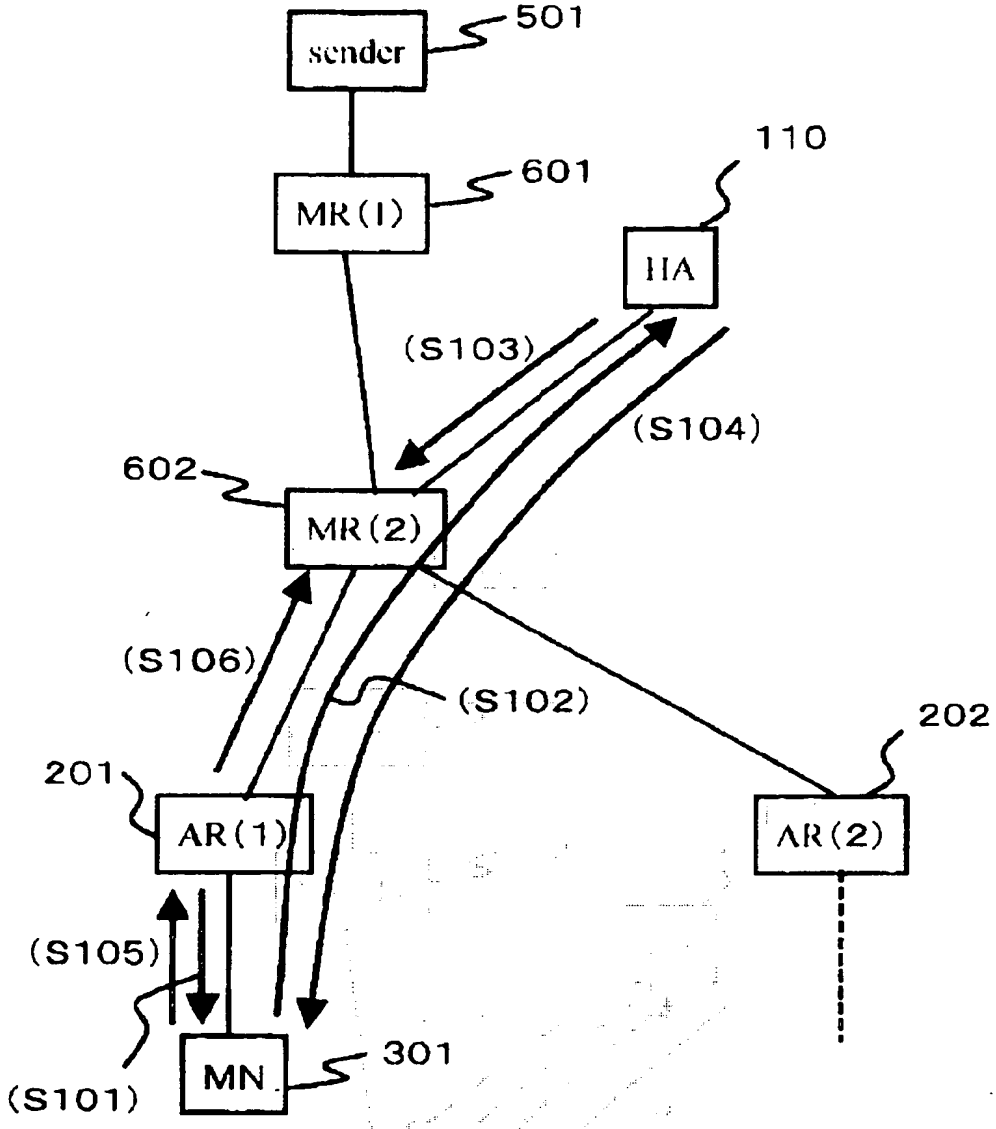

sender
501
110
601
MR(1)
HA
(S103)
(S104)
602
MR(2)
(S106)
(S102)
202
201
AR(1)
AR(2)
(S105)
(S101)
MN
301

Fig. 4

HoA	CoA	Lifetime	Multicast compatible flag	Multicast group (1)			Multicast group (2)		
				Address	Leave flag	Multicast lifetime	Address	Leave flag	Multicast lifetime
HoA(1)	CoA(1)	520	1	MCA(G)	0	10	–	–	–
HoA(a)	CoA(a)	220	1	MCA(A)	0	0	MCA(C)	0	12
HoA(b)	CoA(c)	315	1	MCA(A)	0	3	MCA(C)	0	0
HoA(d)	–	–	–	–	–	–	–	–	–
HoA(e)	CoA(e)	320	1	MCA(B)	0	15	–	–	–
HoA(f)	CoA(f)	400	0	MCA(B)	0	9	MCA(D)	0	0
HoA(g)	CoA(g)	405	1	MCA(C)	0	10	MCA(E)	0	12

Fig. 5

Multicast group address	Number of HoAs	HoA
MCA(A)	2	HoA(m)、HoA(n)
MCA(B)	2	HoA(m)、HoA(k)
MCA(C)	1	HoA(l)
MCA(G)	1	HoA(1)
MCA(H)	3	HoA(u)、HoA(v)、HoA(w)
MCA(I)	1	HoA(x)
MCA(I)	1	HoA(y)

Fig. 6

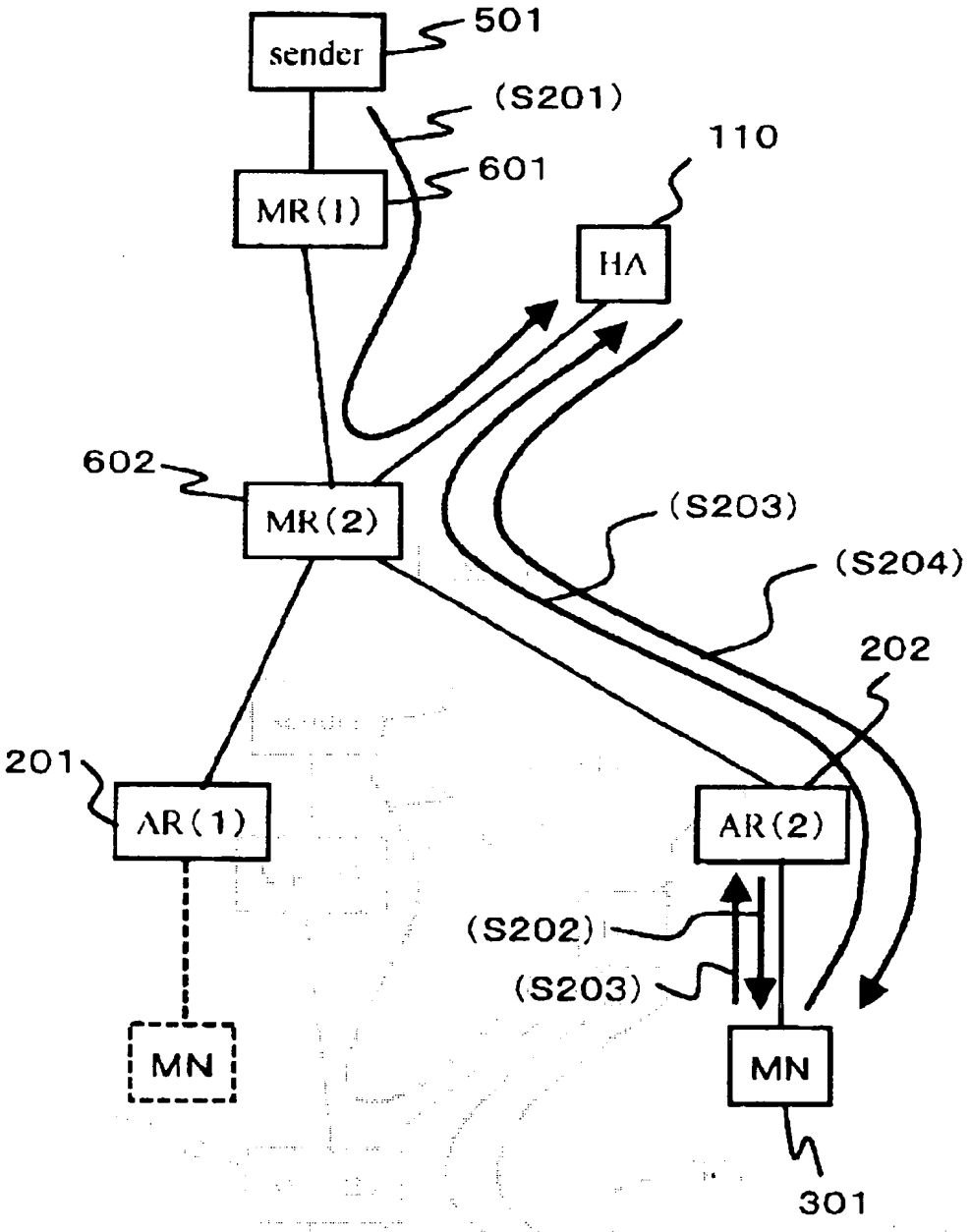

sender
501
(S201)
601
110
MR(1)
HA
602
MR(2)
(S203)
(S204)
202
201
AR(1)
AR(2)
(S202)
(S203)
MN
MN
301

Fig. 7

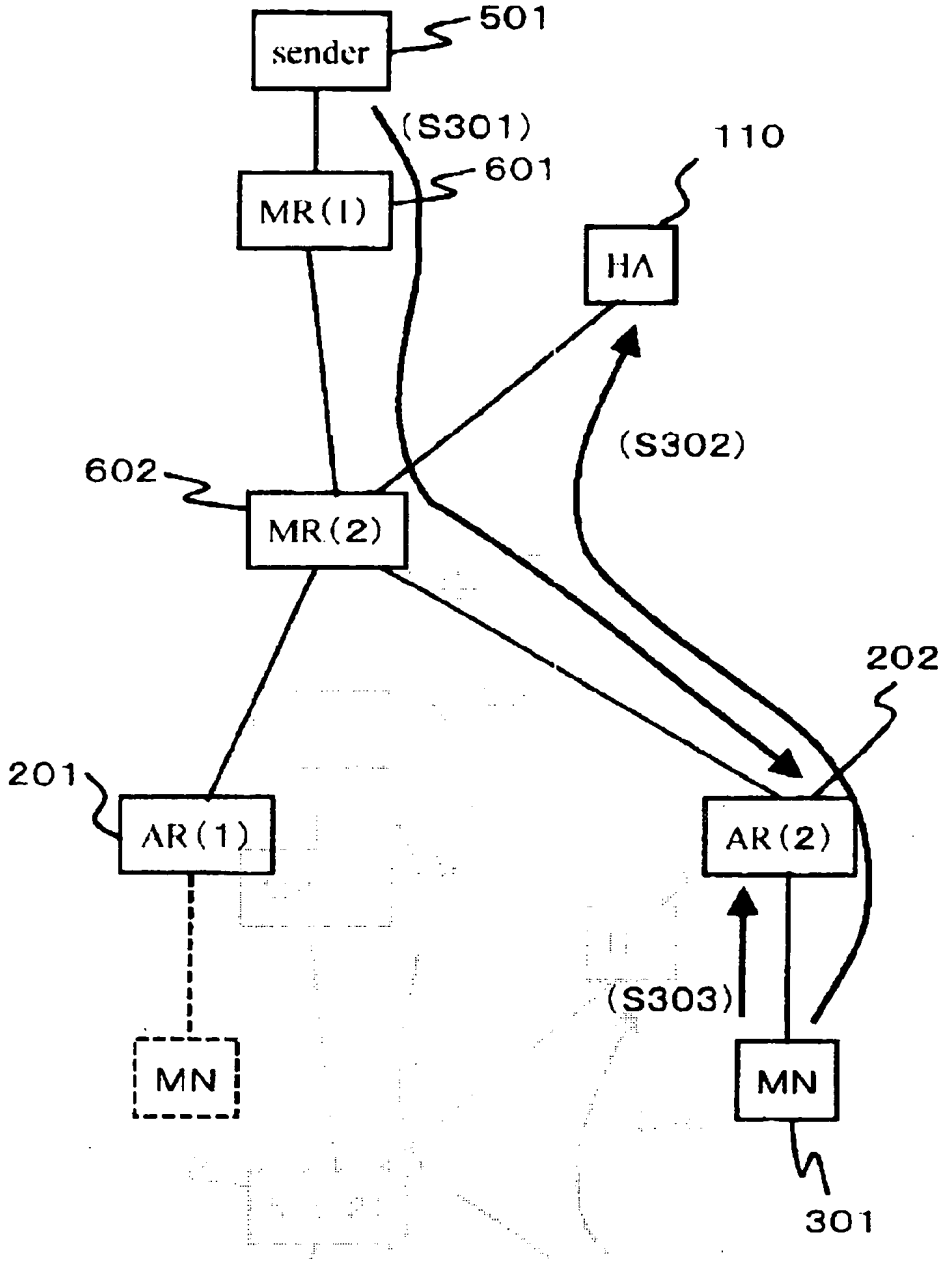

sender
501
(S301)
110
601
MR(1)
HA
(S302)
602
MR(2)
202
201
AR(1)
AR(2)
(S303)
MN
MN
301

Fig. 8

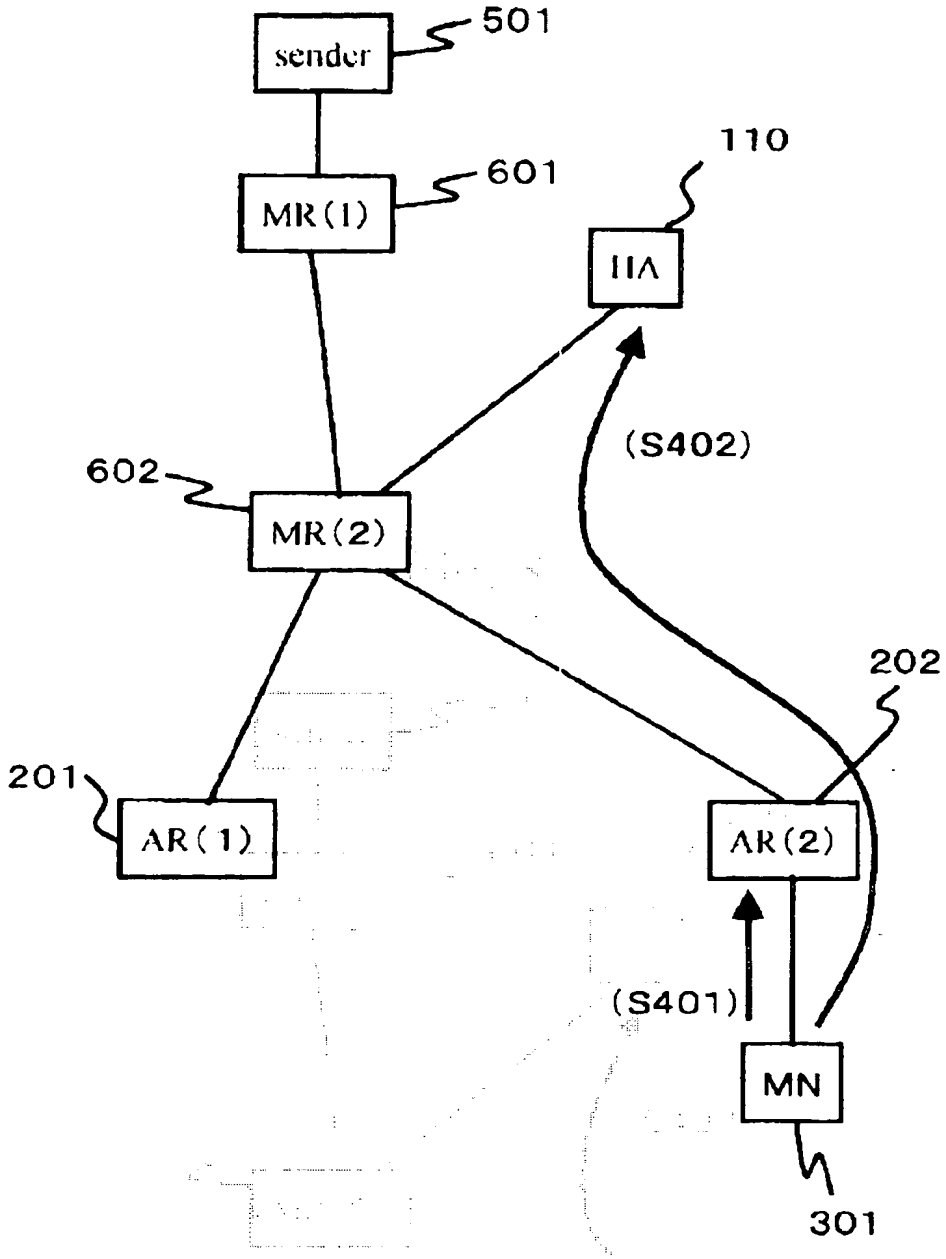

sender
501
MR(1)
601
110
HA
(S402)
602
MR(2)
202
201
AR(1)
AR(2)
(S401)
MN
301

Fig. 9

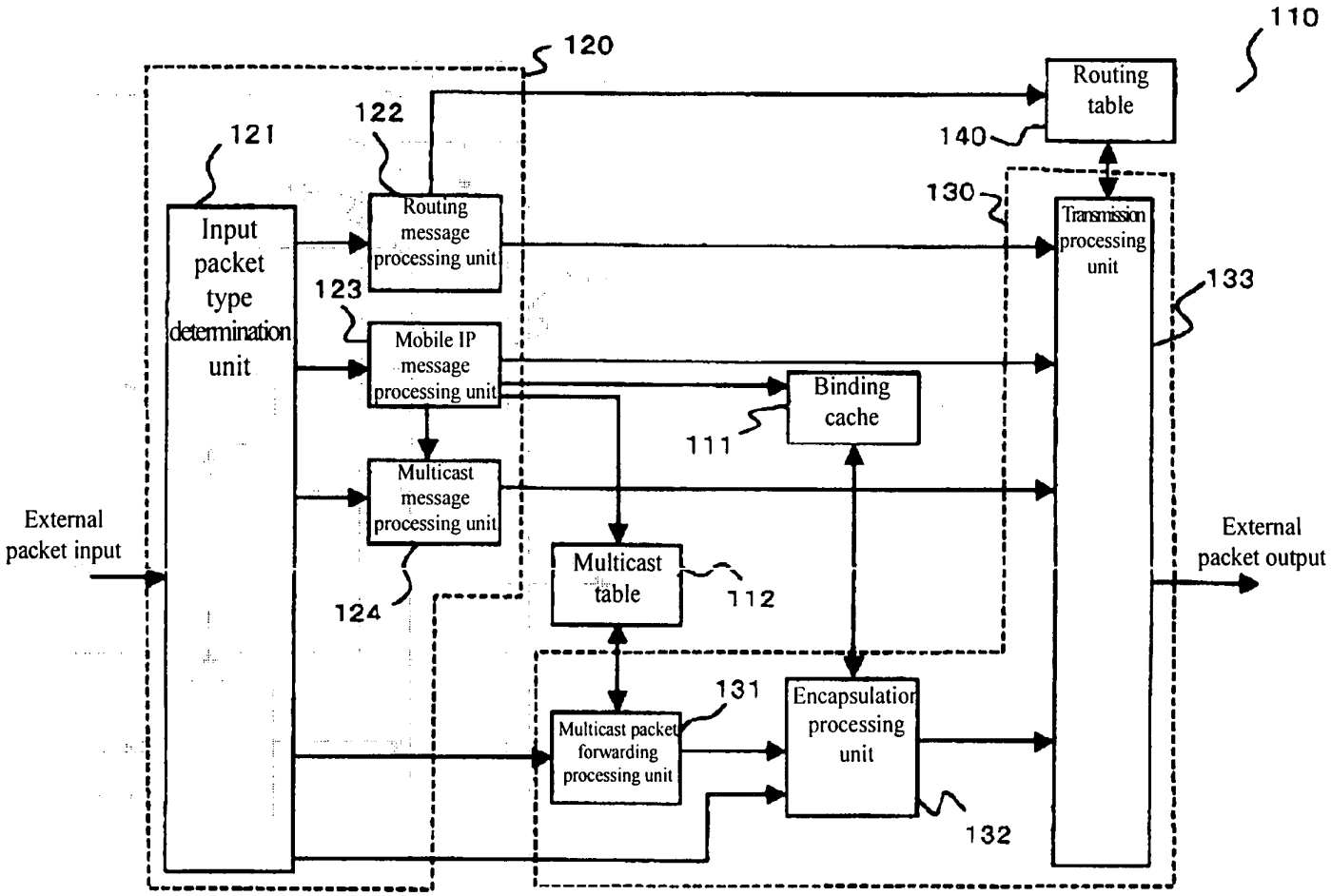
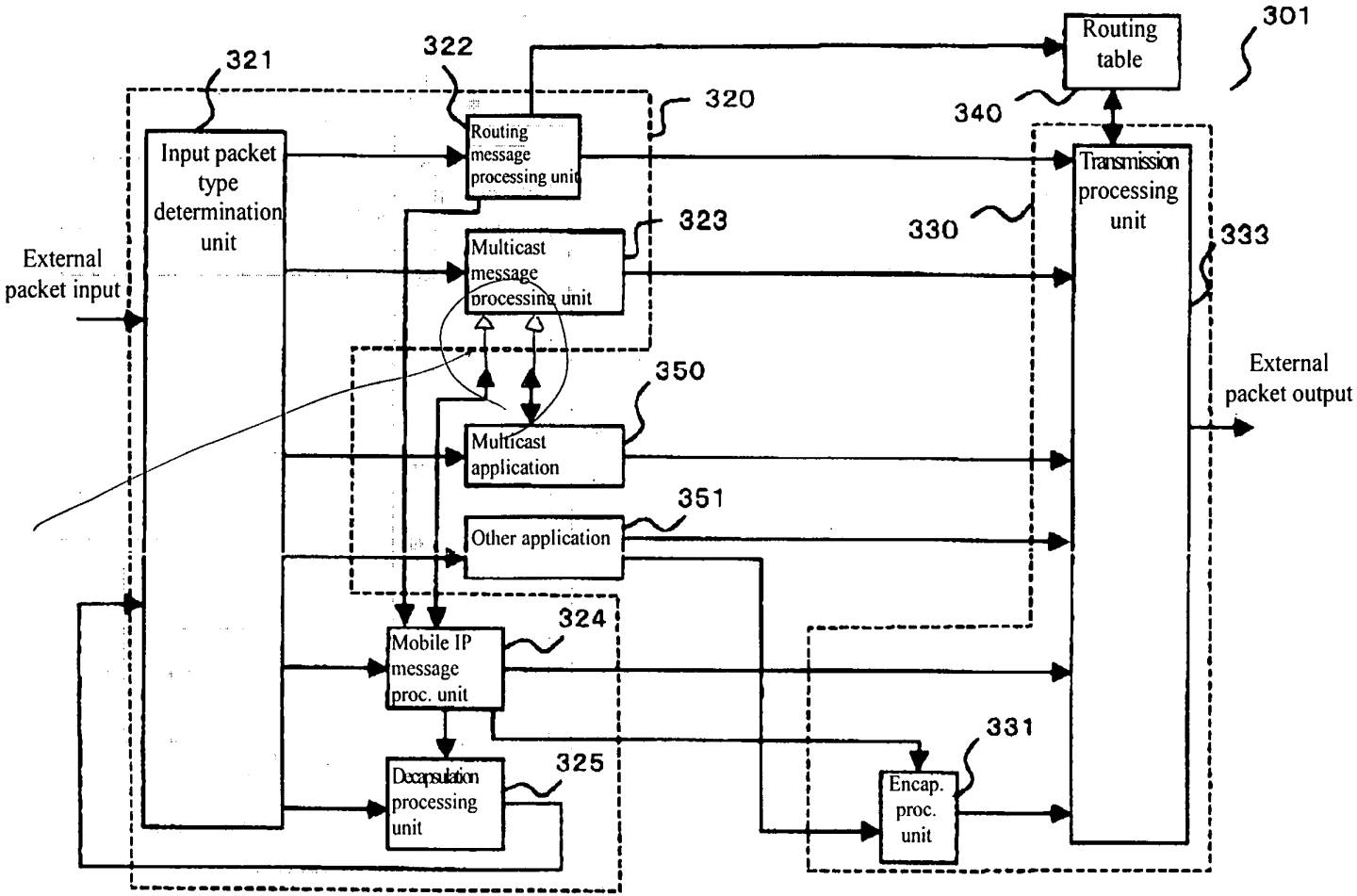

110
120
Routing table
140
121
122
130
Input packet type determination unit
Routing message processing unit
Transmission processing unit
133
123
Mobile IP message processing unit
Binding cache
111
Multicast message processing unit
External packet input
External packet output
Multicast table
112
124
131
Encapsulation processing unit
Multicast packet forwarding processing unit
132

Fig. 10



Feb. 19. 2004
H.O.
H.T.

Fig. 11

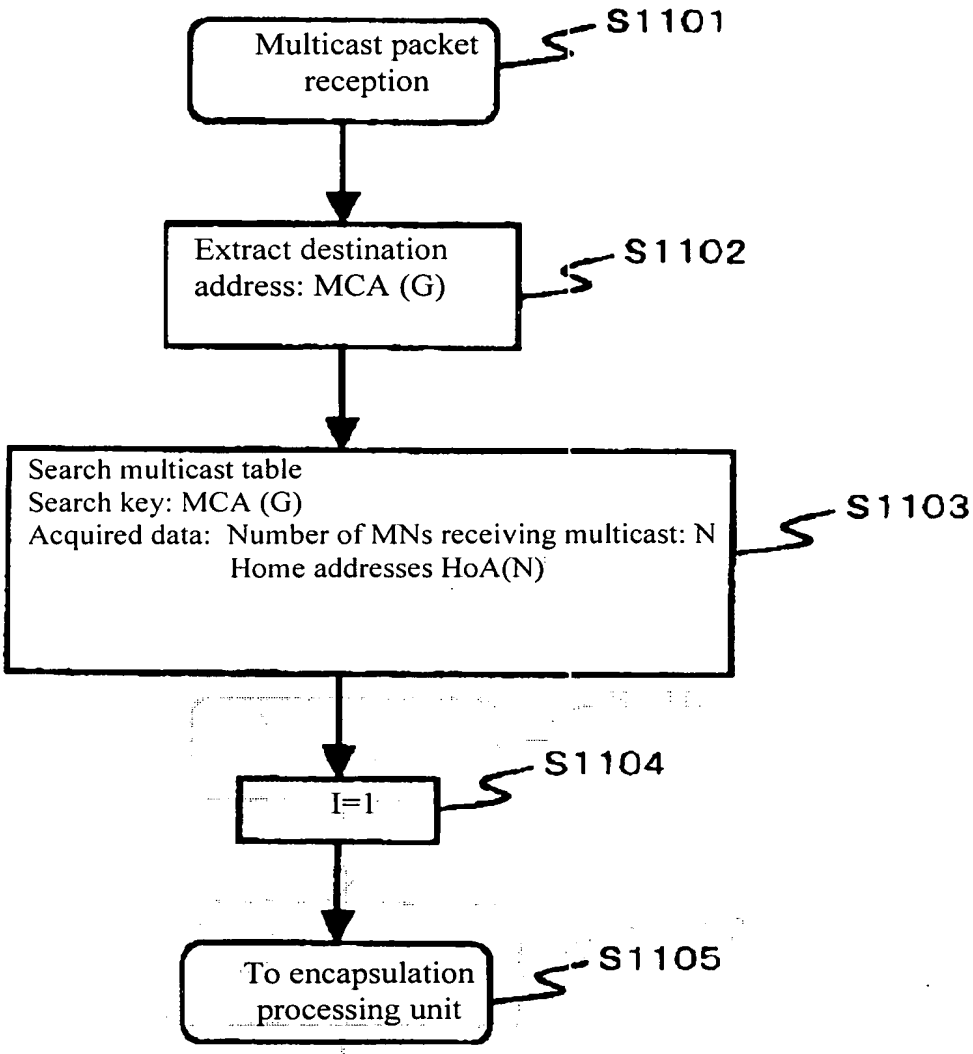

Multicast packet reception
S1101
Extract destination address: MCA (G)
S1102
Search multicast table
Search key: MCA (G)
Acquired data: Number of MNs receiving multicast: N
Home addresses HoA(N)
S1103
I=1
S1104
To encapsulation processing unit
S1105

Fig. 12

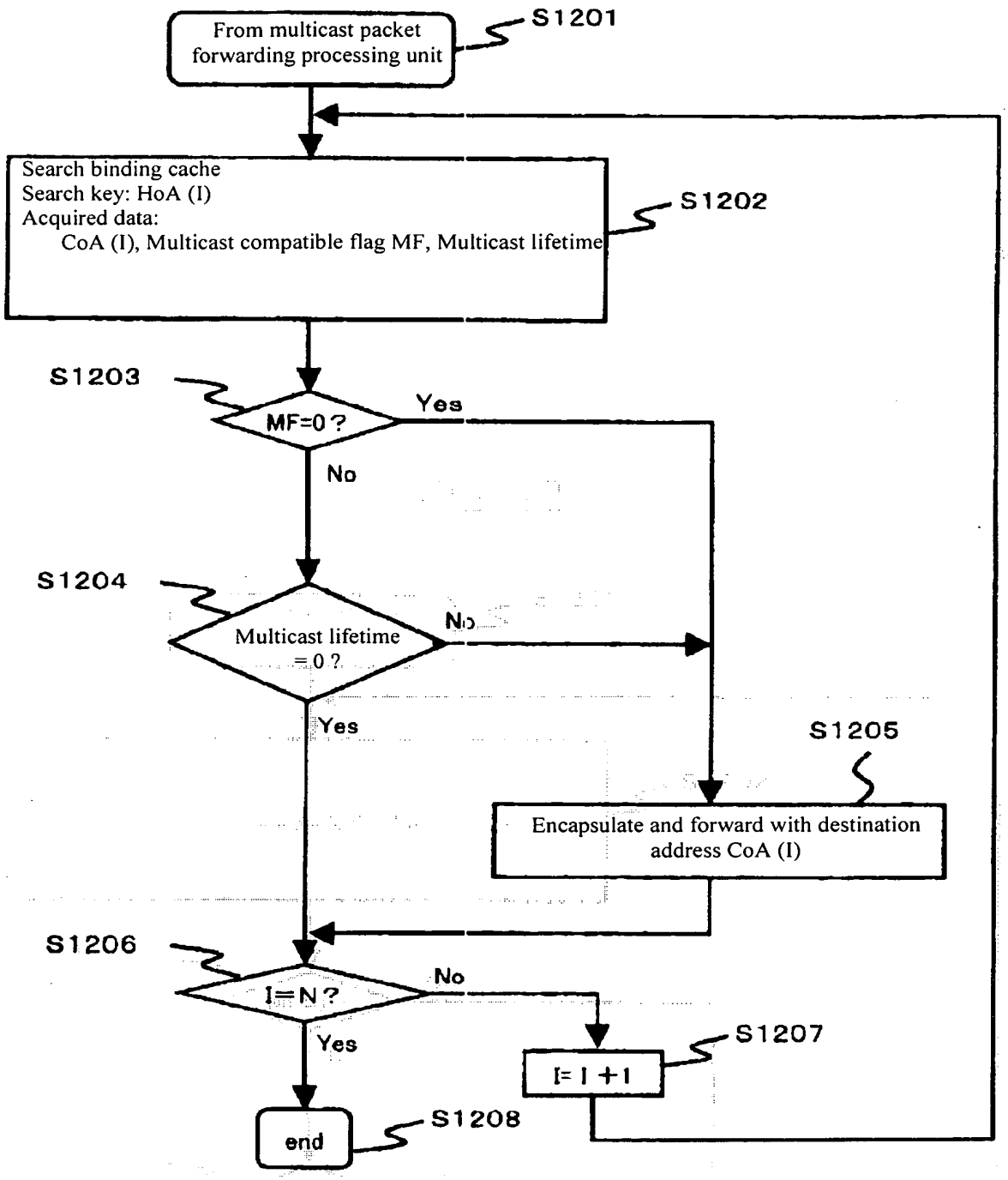

From multicast packet forwarding processing unit
S1201
Search binding cache
Search key: HoA (I)
Acquired data:
CoA (I), Multicast compatible flag MF, Multicast lifetime
S1202
S1203
MF=0 ?
Yes
No
S1204
Multicast lifetime = 0 ?
No
Yes
S1205
Encapsulate and forward with destination address CoA (I)
S1206
I=N ?
No
Yes
S1207
I= I +1
S1208
end

Fig. 13

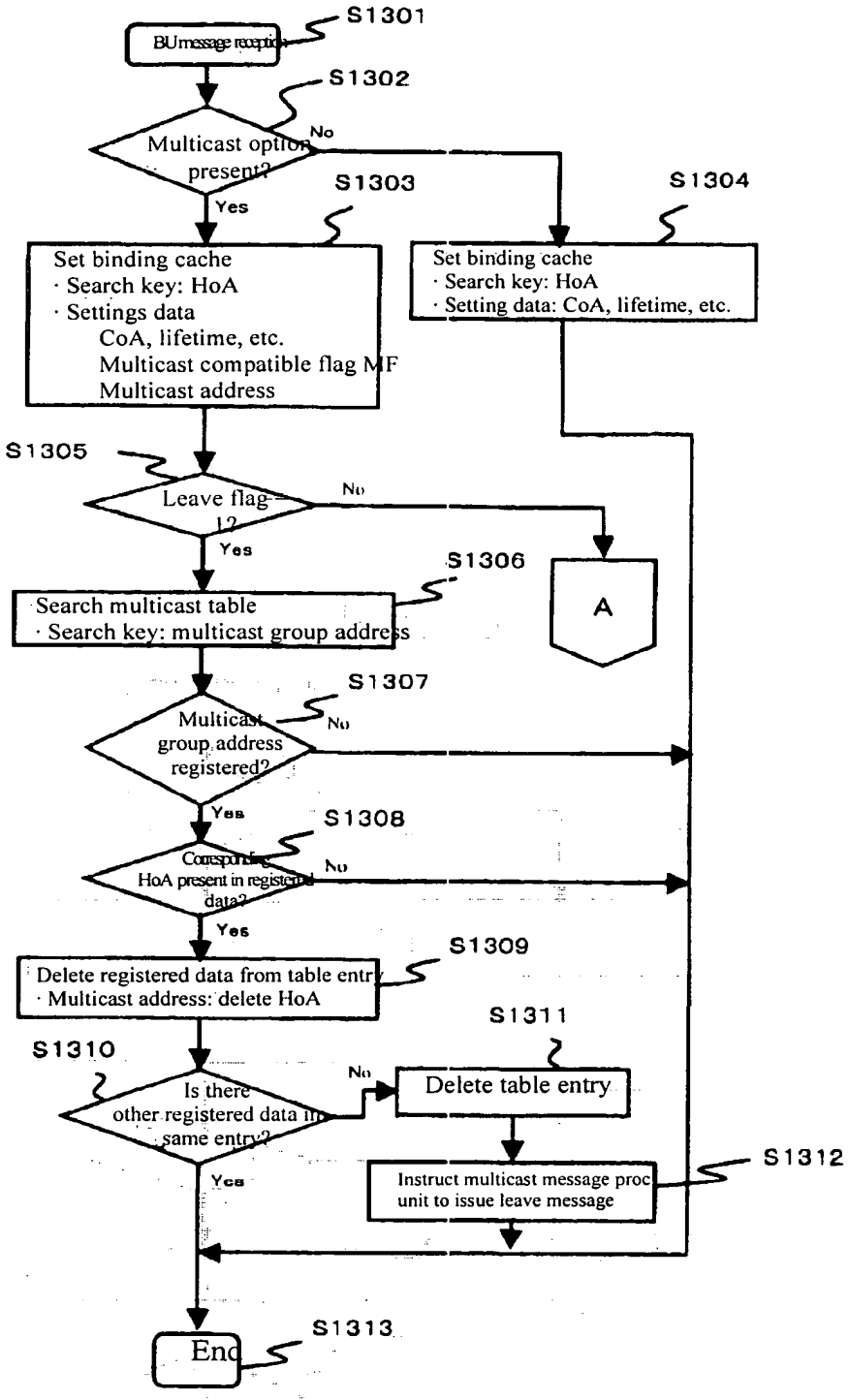

S1301
BU message reception
S1302
Multicast option present?
No
Yes
S1303
Set binding cache
· Search key: HoA
· Settings data
CoA, lifetime, etc.
Multicast compatible flag MF
Multicast address
S1304
Set binding cache
· Search key: HoA
· Setting data: CoA, lifetime, etc.
S1305
Leave flag = 1?
No
Yes
S1306
Search multicast table
· Search key: multicast group address
A
S1307
Multicast group address registered?
No
Yes
S1308
Corresponding HoA present in registered data?
No
Yes
S1309
Delete registered data from table entry
· Multicast address: delete HoA
S1310
Is there other registered data in same entry?
No
Yes
S1311
Delete table entry
S1312
Instruct multicast message proc unit to issue leave message
S1313
End

Fig. 14

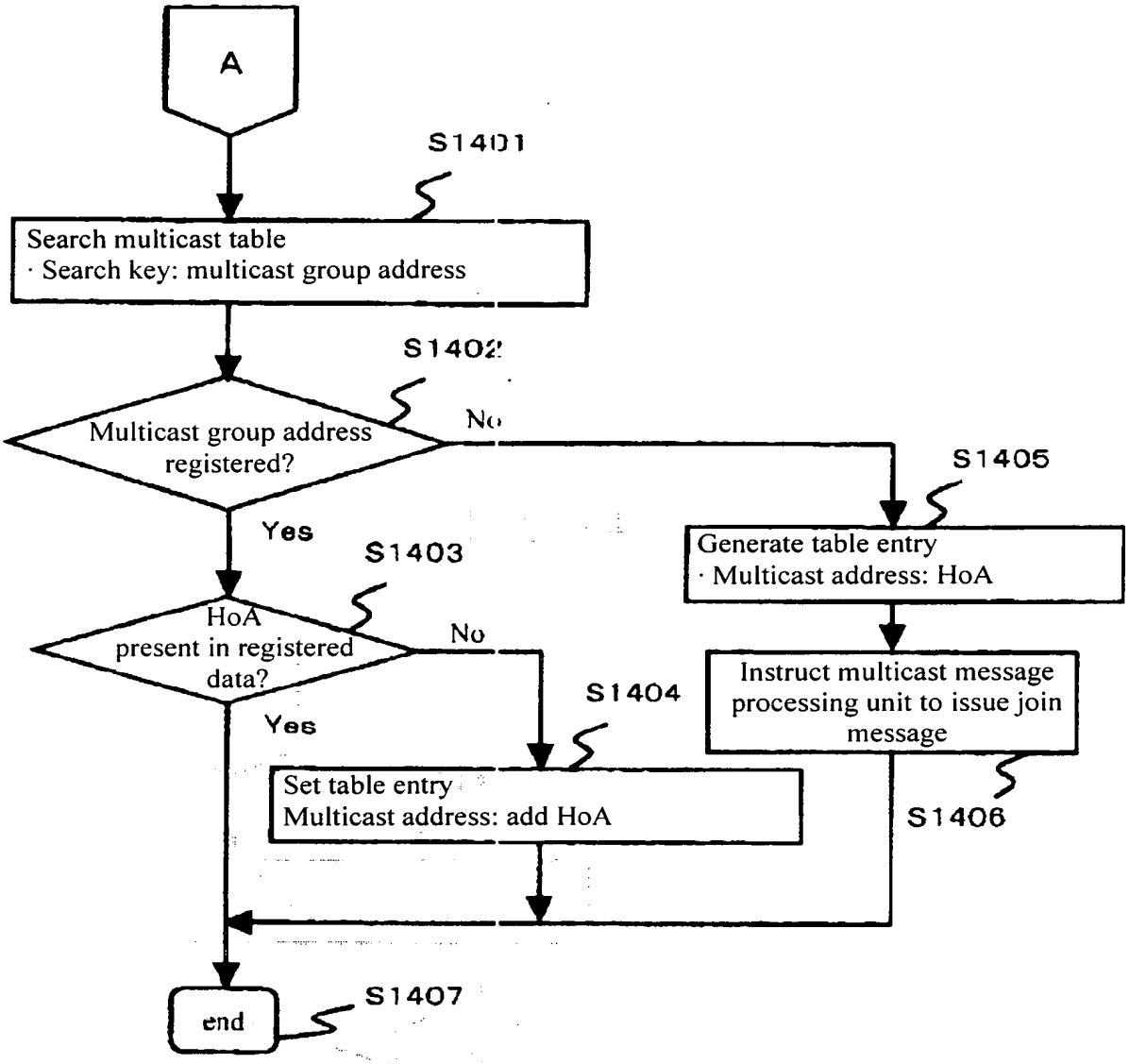

A
S1401
Search multicast table
· Search key: multicast group address
S1402
Multicast group address registered?
No
Yes
S1405
Generate table entry
· Multicast address: HoA
S1403
HoA present in registered data?
No
Yes
S1404
Instruct multicast message processing unit to issue join message
Set table entry
Multicast address: add HoA
S1406
end
S1407

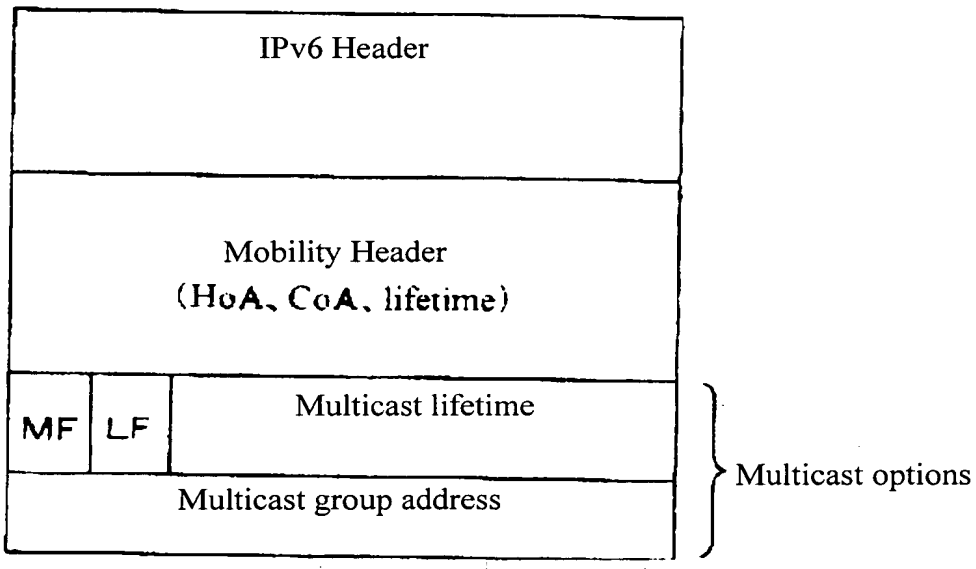
Fig. 15

Multicast group address	Number of receiving MNs	HoA of receiving MNs
G 1	4	HoA1、HoA2、HoA3、HoA7
G 2	2	HoA5、HoA6

Fig. 16

Home address	CoA	Lifetime	Multicast compatible flag	Multicast lifetime	Leave flag	Multicast address
HoA1	CoA1-1	520	1	10	0	G1
HoA2	CoA2-1	220	1	0	0	G9
HoA3	CoA3-1	315	1	3	0	G1
HoA4	–					
HoA5	CoA5-1	320	1	15	0	G1
HoA6	CoA6-1	400	0	–	0	G9
HoA7	CoA7-1	405	1	10	0	G1

Fig. 17



MF: Multicast compatible flag
LF: Leave flag

Fig. 18

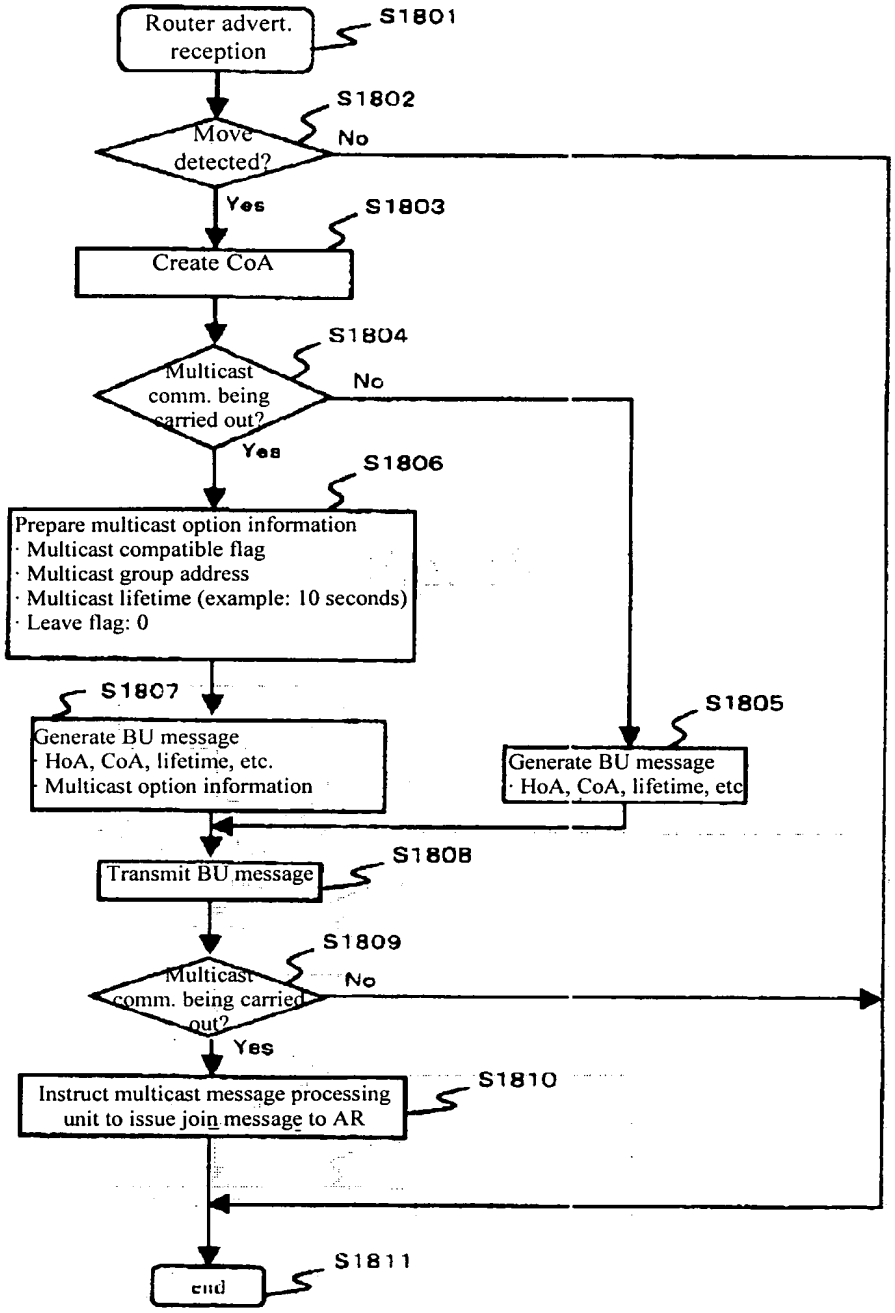

Router advert. reception
S1801
S1802
Move detected?
No
Yes
S1803
Create CoA
S1804
Multicast comm. being carried out?
No
Yes
S1806
Prepare multicast option information
· Multicast compatible flag
· Multicast group address
· Multicast lifetime (example: 10 seconds)
· Leave flag: 0
S1807
Generate BU message
· HoA, CoA, lifetime, etc.
· Multicast option information
S1805
Generate BU message
· HoA, CoA, lifetime, etc
S1808
Transmit BU message
S1809
Multicast comm. being carried out?
No
Yes
S1810
Instruct multicast message processing unit to issue join message to AR
S1811
end

Fig. 19

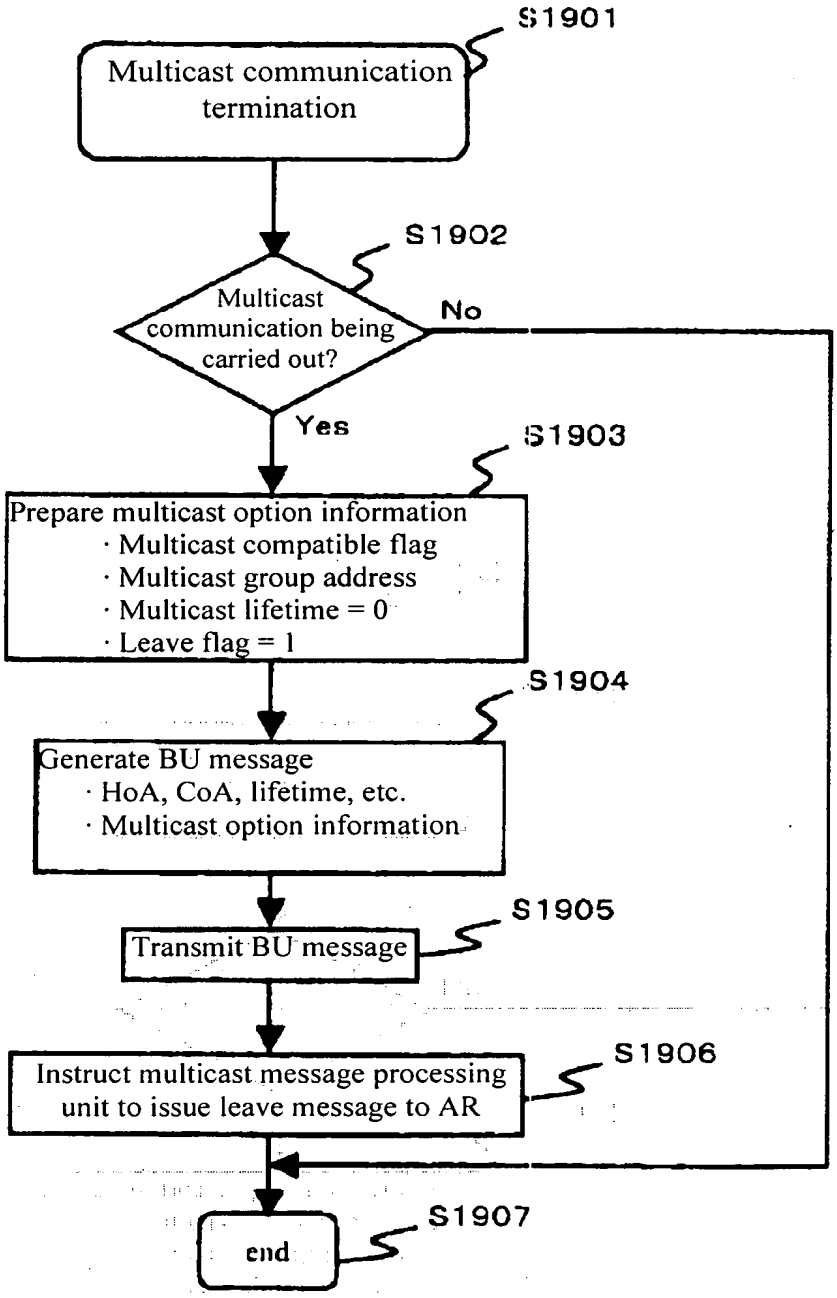

S1901
Multicast communication termination
S1902
Multicast communication being carried out?
No
Yes
S1903
Prepare multicast option information
· Multicast compatible flag
· Multicast group address
· Multicast lifetime = 0
· Leave flag = 1
S1904
Generate BU message
· HoA, CoA, lifetime, etc.
· Multicast option information
S1905
Transmit BU message
S1906
Instruct multicast message processing unit to issue leave message to AR
S1907
end

Fig. 20

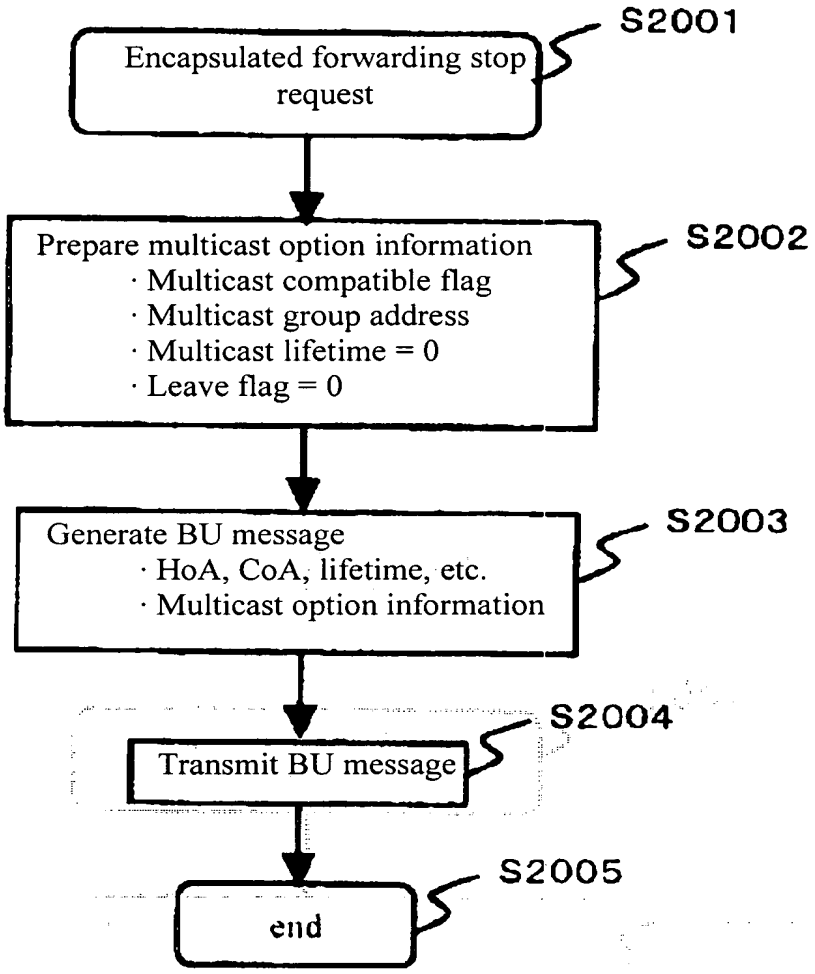

S2001
Encapsulated forwarding stop request
S2002
Prepare multicast option information
· Multicast compatible flag
· Multicast group address
· Multicast lifetime = 0
· Leave flag = 0
S2003
Generate BU message
· HoA, CoA, lifetime, etc.
· Multicast option information
S2004
Transmit BU message
S2005
end

Fig. 21

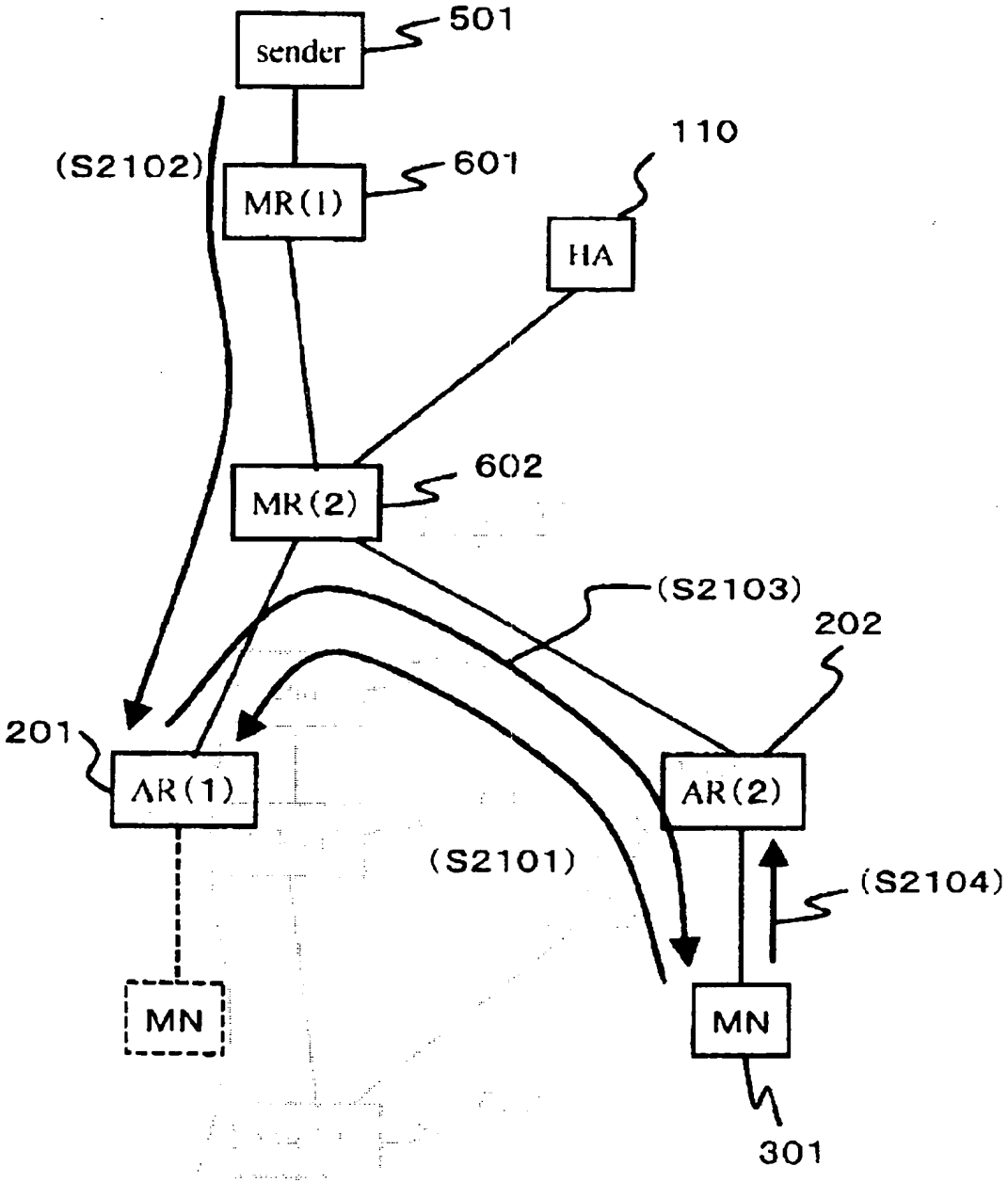

sender
501
(S2102)
MR(1)
601
110
HA
MR(2)
602
(S2103)
202
201
AR(1)
AR(2)
(S2101)
(S2104)
MN
MN
301

Fig. 22

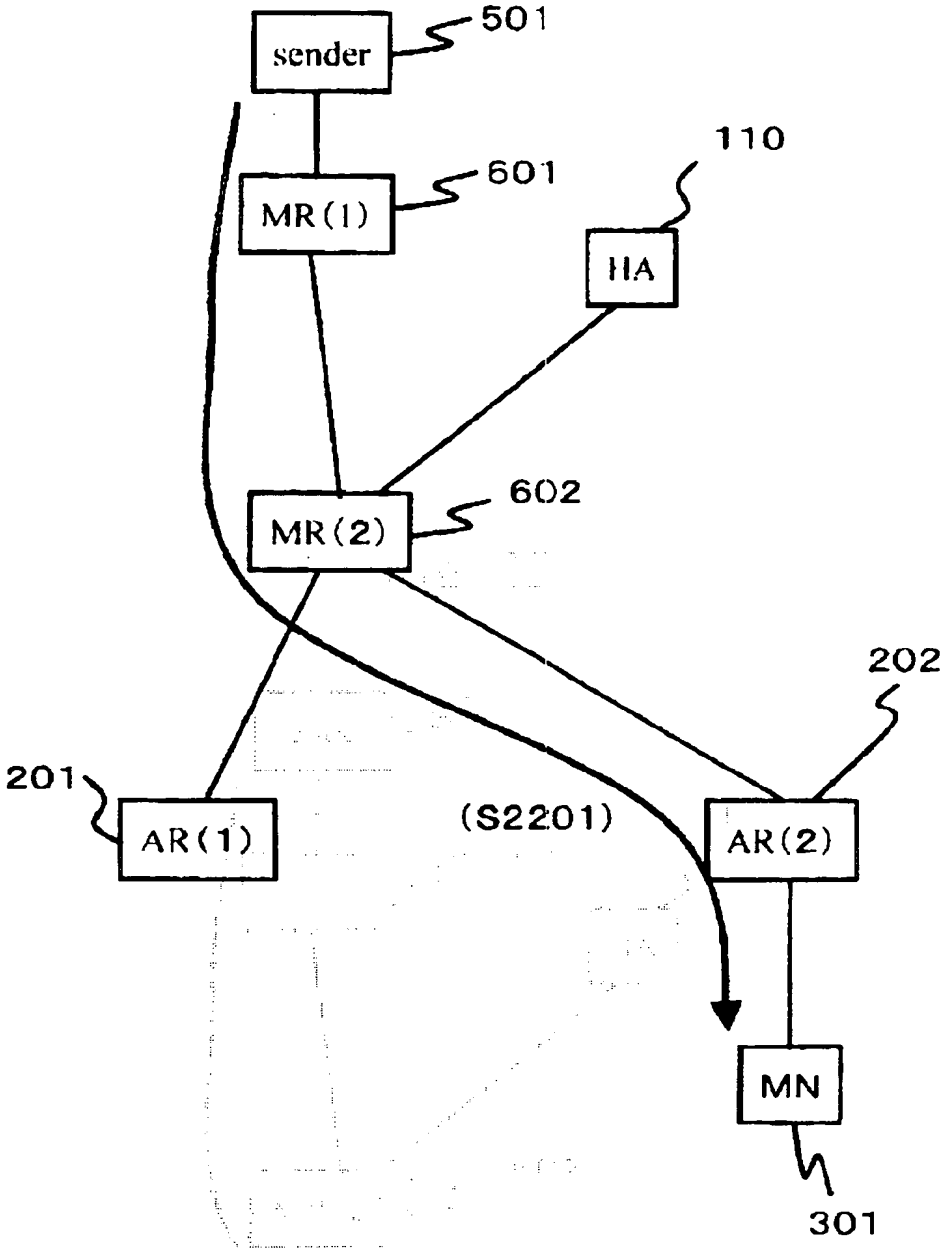


Fig. 23

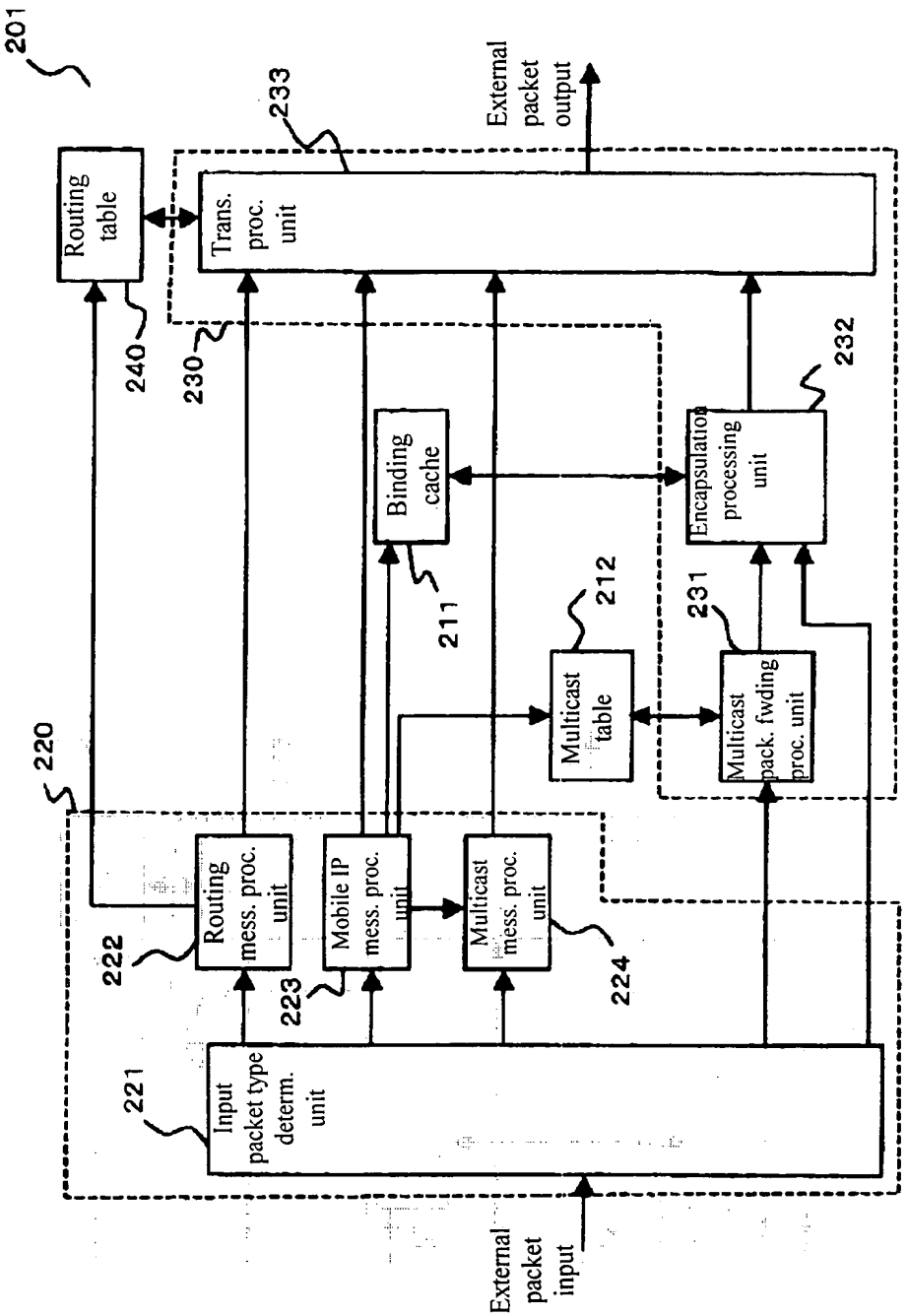

201
Routing table
Trans. proc. unit
233
External packet output
240
230
232
Binding cache
Encapsulation processing unit
211
212
231
Multicast table
Multicast pack. fwding proc. unit
220
Routing mess. proc. unit
Mobile IP mess. proc. unit
Multicast mess. proc. unit
222
223
224
221
Input packet type determ. unit
External packet input

Fig. 24

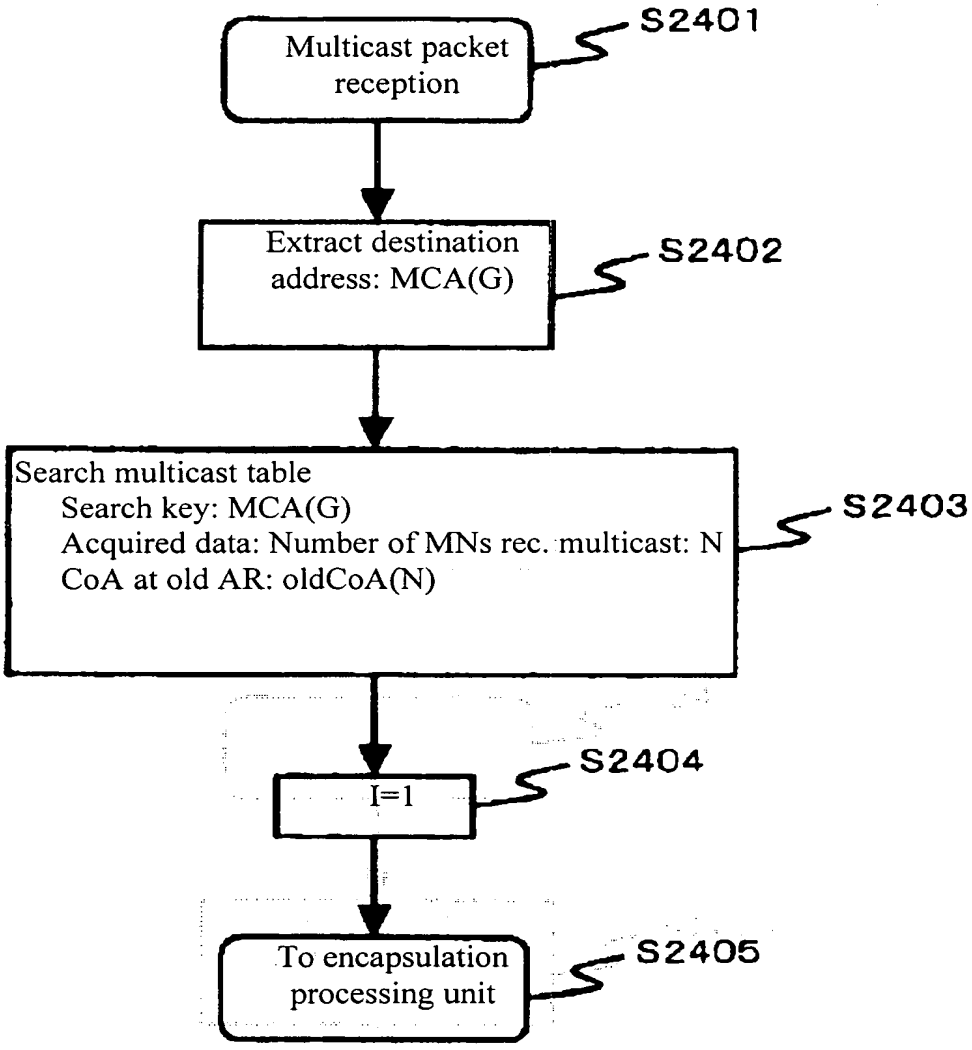

Multicast packet reception
S2401
Extract destination address: MCA(G)
S2402
Search multicast table
Search key: MCA(G)
Acquired data: Number of MNs rec. multicast: N
CoA at old AR: oldCoA(N)
S2403
I=1
S2404
To encapsulation processing unit
S2405

Fig. 25

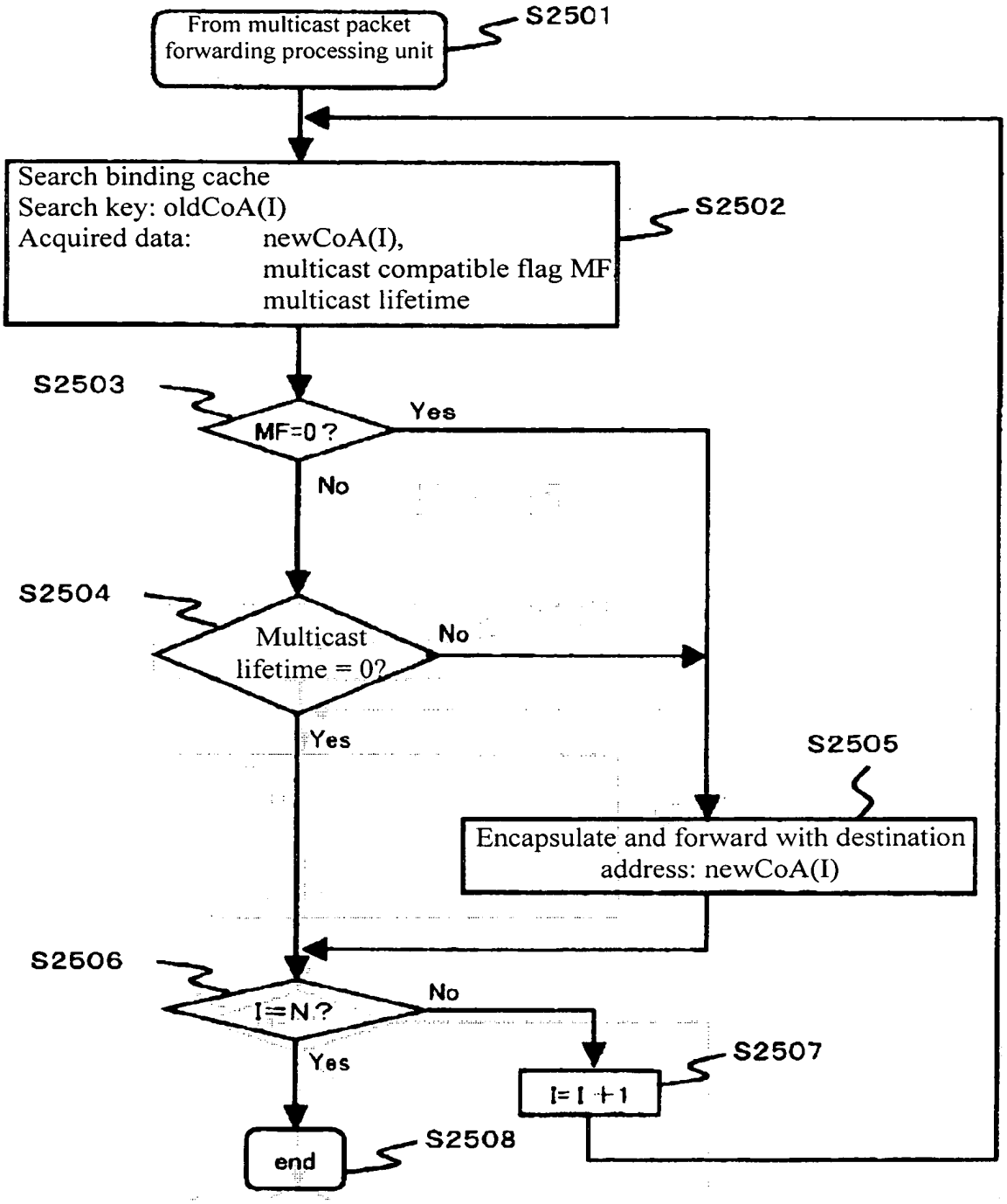

From multicast packet forwarding processing unit
S2501
Search binding cache
Search key: oldCoA(I)
Acquired data: newCoA(I),
multicast compatible flag MF
multicast lifetime
S2502
S2503
MF=0 ?
Yes
No
S2504
Multicast lifetime = 0?
No
Yes
S2505
Encapsulate and forward with destination address: newCoA(I)
S2506
I=N ?
No
Yes
S2507
I=I +1
end
S2508

Fig. 26

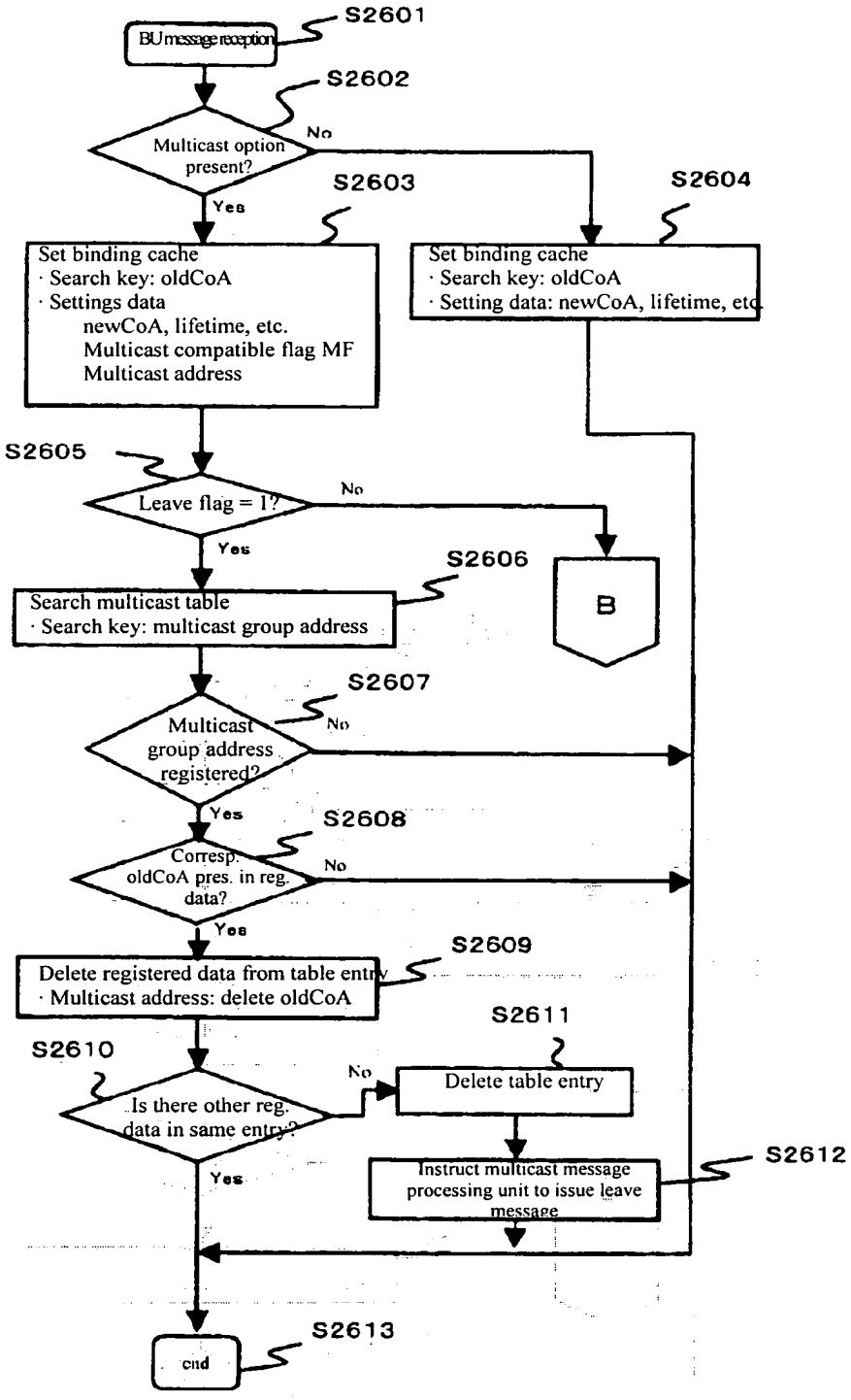

S2601
BU message reception
S2602
Multicast option present?
No
Yes
S2603
Set binding cache
· Search key: oldCoA
· Settings data
newCoA, lifetime, etc.
Multicast compatible flag MF
Multicast address
S2604
Set binding cache
· Search key: oldCoA
· Setting data: newCoA, lifetime, etc
S2605
Leave flag = 1?
No
Yes
S2606
Search multicast table
· Search key: multicast group address
B
S2607
Multicast group address registered?
No
Yes
S2608
Corresp. oldCoA pres. in reg. data?
No
Yes
S2609
Delete registered data from table entry
· Multicast address: delete oldCoA
S2610
Is there other reg. data in same entry?
No
Yes
S2611
Delete table entry
S2612
Instruct multicast message processing unit to issue leave message
S2613
end

Fig. 27

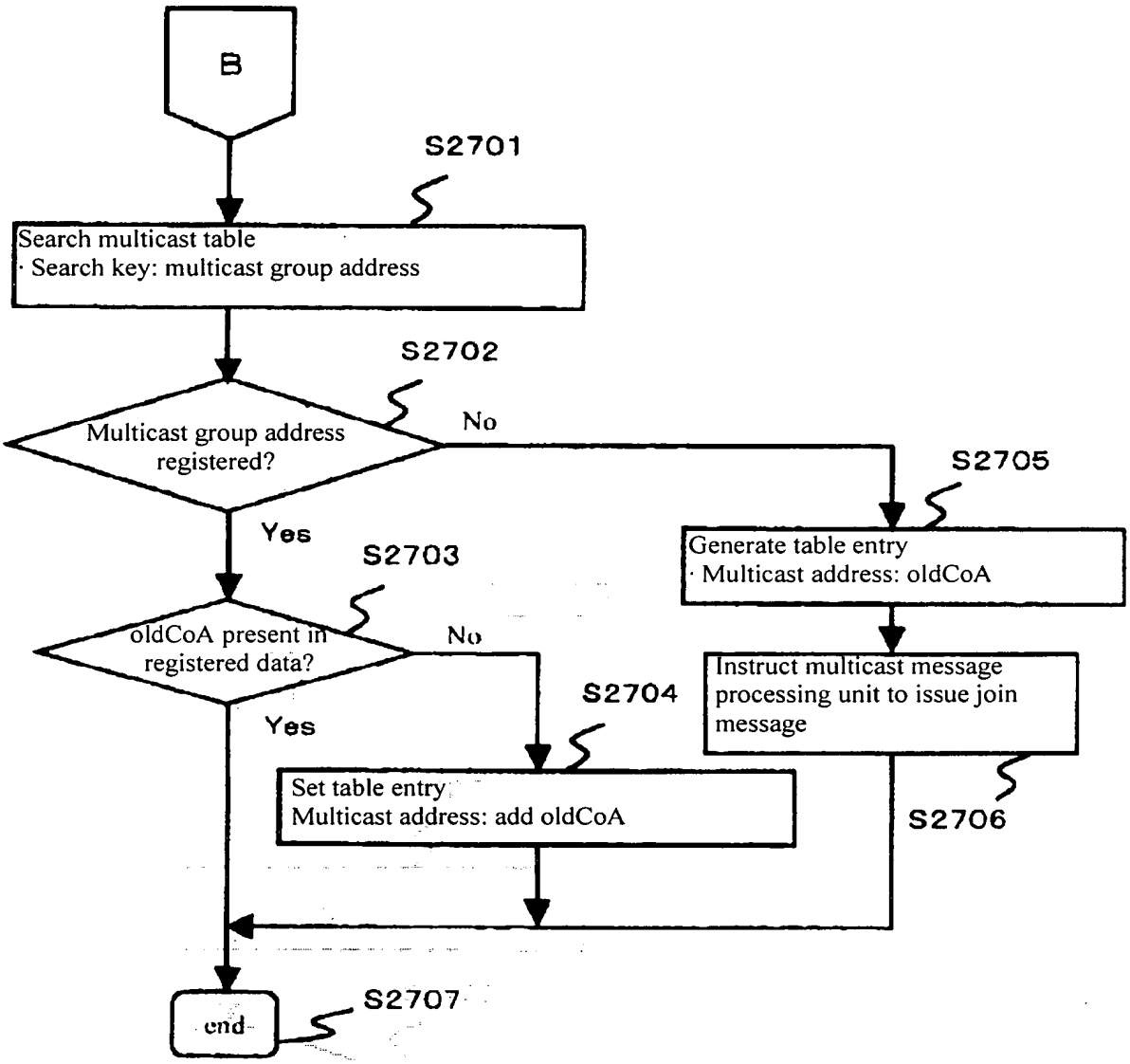

B
S2701
Search multicast table
· Search key: multicast group address
S2702
Multicast group address registered?
No
Yes
S2705
Generate table entry
· Multicast address: oldCoA
S2703
oldCoA present in registered data?
No
Yes
S2704
Instruct multicast message processing unit to issue join message
Set table entry
Multicast address: add oldCoA
S2706
end
S2707

Fig. 28

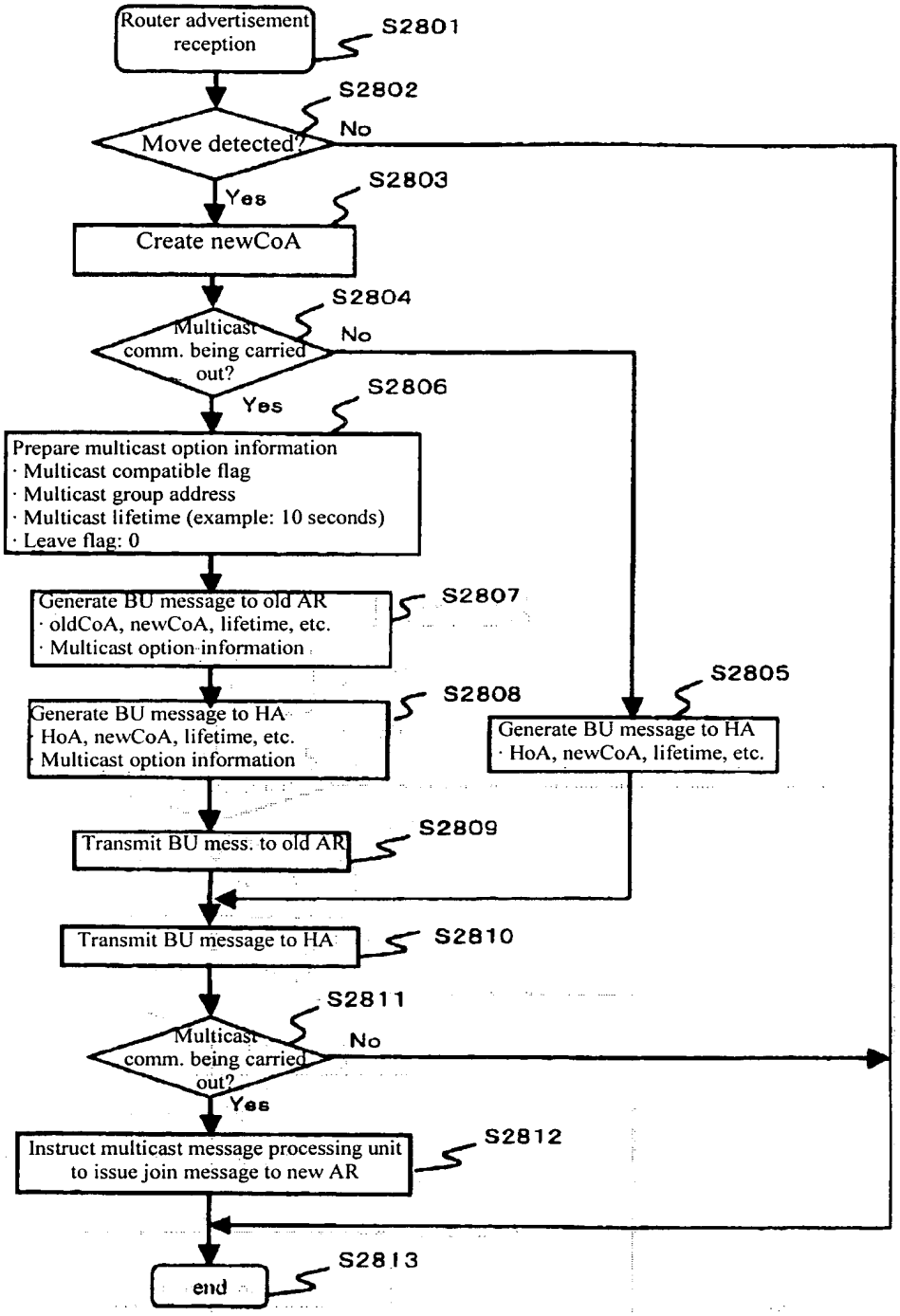

Router advertisement reception
S2801
S2802
Move detected?
No
Yes
S2803
Create newCoA
S2804
Multicast comm. being carried out?
No
Yes
S2806
Prepare multicast option information
· Multicast compatible flag
· Multicast group address
· Multicast lifetime (example: 10 seconds)
· Leave flag: 0
Generate BU message to old AR
· oldCoA, newCoA, lifetime, etc.
· Multicast option information
S2807
S2805
Generate BU message to HA
· HoA, newCoA, lifetime, etc.
S2808
Generate BU message to HA
· HoA, newCoA, lifetime, etc.
· Multicast option information
Transmit BU mess. to old AR
S2809
Transmit BU message to HA
S2810
S2811
Multicast comm. being carried out?
No
Yes
Instruct multicast message processing unit to issue join message to new AR
S2812
end
S2813

Fig. 29

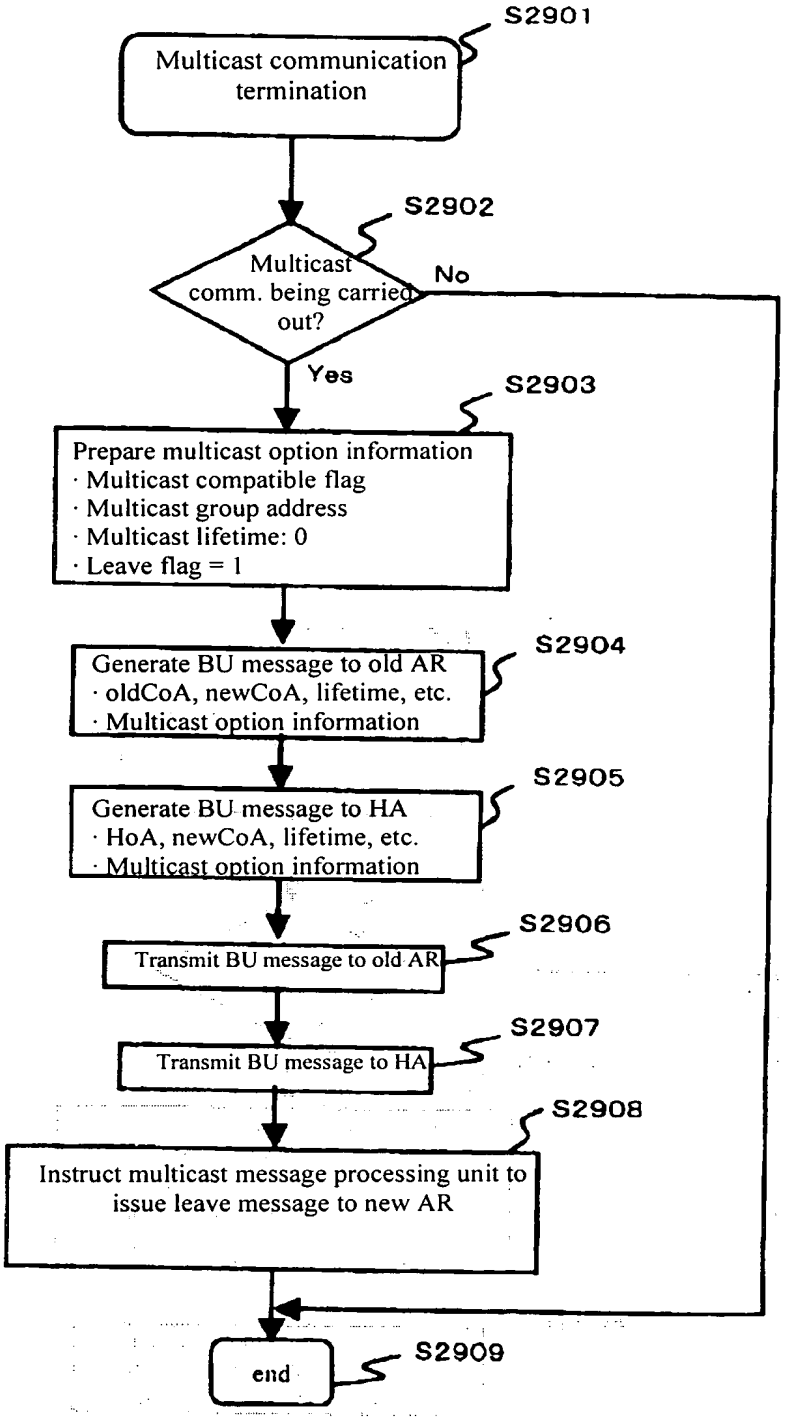

S2901
Multicast communication termination
S2902
Multicast comm. being carried out?
No
Yes
S2903
Prepare multicast option information
· Multicast compatible flag
· Multicast group address
· Multicast lifetime: 0
· Leave flag = 1
S2904
Generate BU message to old AR
· oldCoA, newCoA, lifetime, etc.
· Multicast option information
S2905
Generate BU message to HA
· HoA, newCoA, lifetime, etc.
· Multicast option information
S2906
Transmit BU message to old AR
S2907
Transmit BU message to HA
S2908
Instruct multicast message processing unit to issue leave message to new AR
end
S2909

Fig. 30

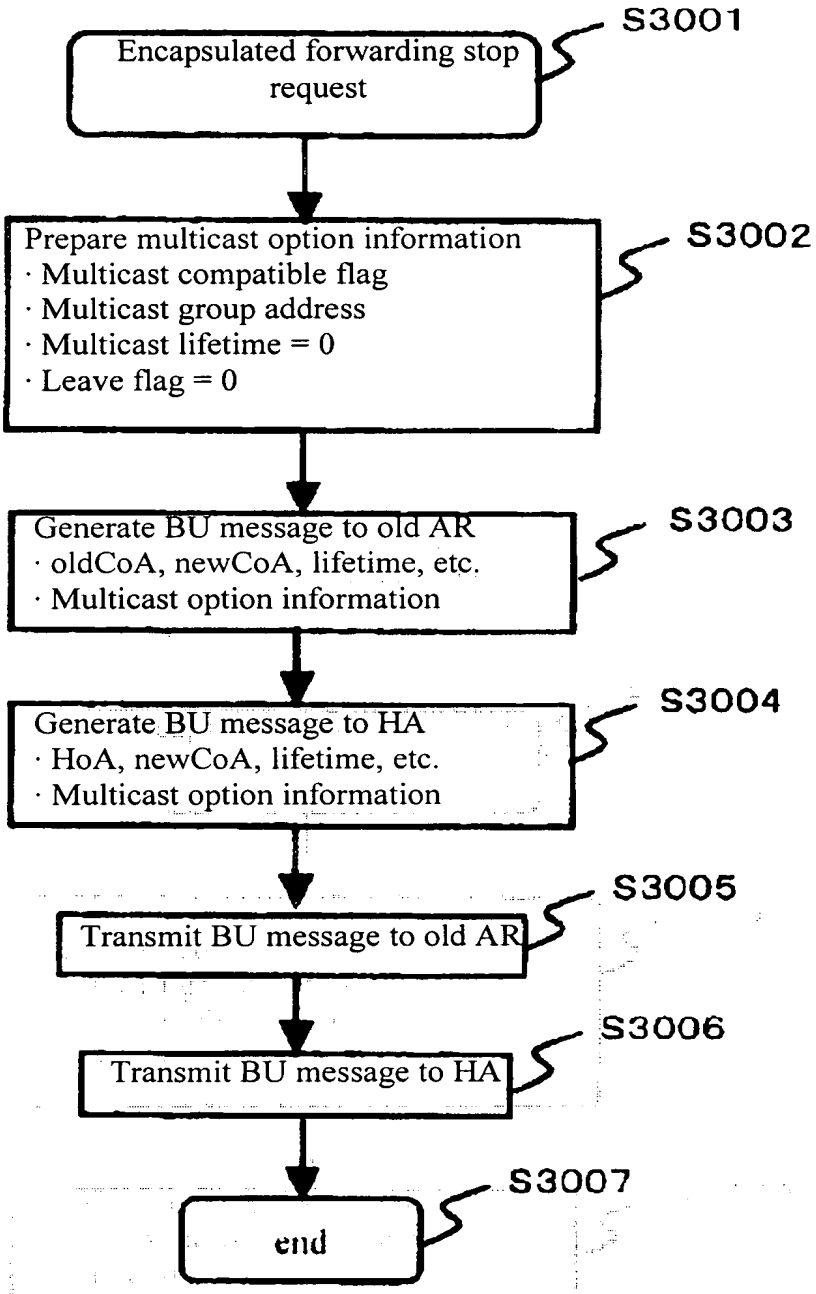

S3001
Encapsulated forwarding stop request
S3002
Prepare multicast option information
· Multicast compatible flag
· Multicast group address
· Multicast lifetime = 0
· Leave flag = 0
S3003
Generate BU message to old AR
· oldCoA, newCoA, lifetime, etc.
· Multicast option information
S3004
Generate BU message to HA
· HoA, newCoA, lifetime, etc.
· Multicast option information
S3005
Transmit BU message to old AR
S3006
Transmit BU message to HA
S3007
end

Fig. 31

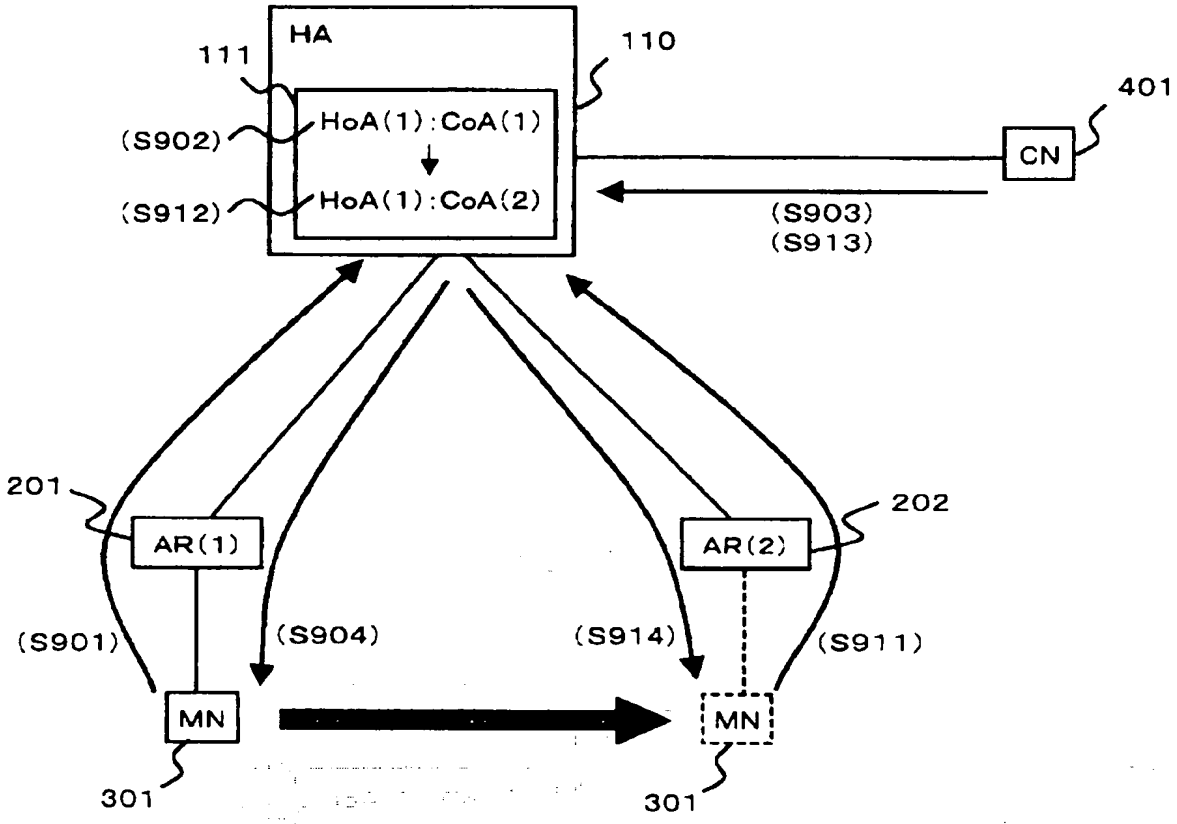

HA
111
110
HoA(1):CoA(1)
(S902)
HoA(1):CoA(2)
(S912)
401
CN
(S903)
(S913)
201
AR(1)
202
AR(2)
(S901)
(S904)
(S914)
(S911)
MN
MN
301
301

Fig. 32

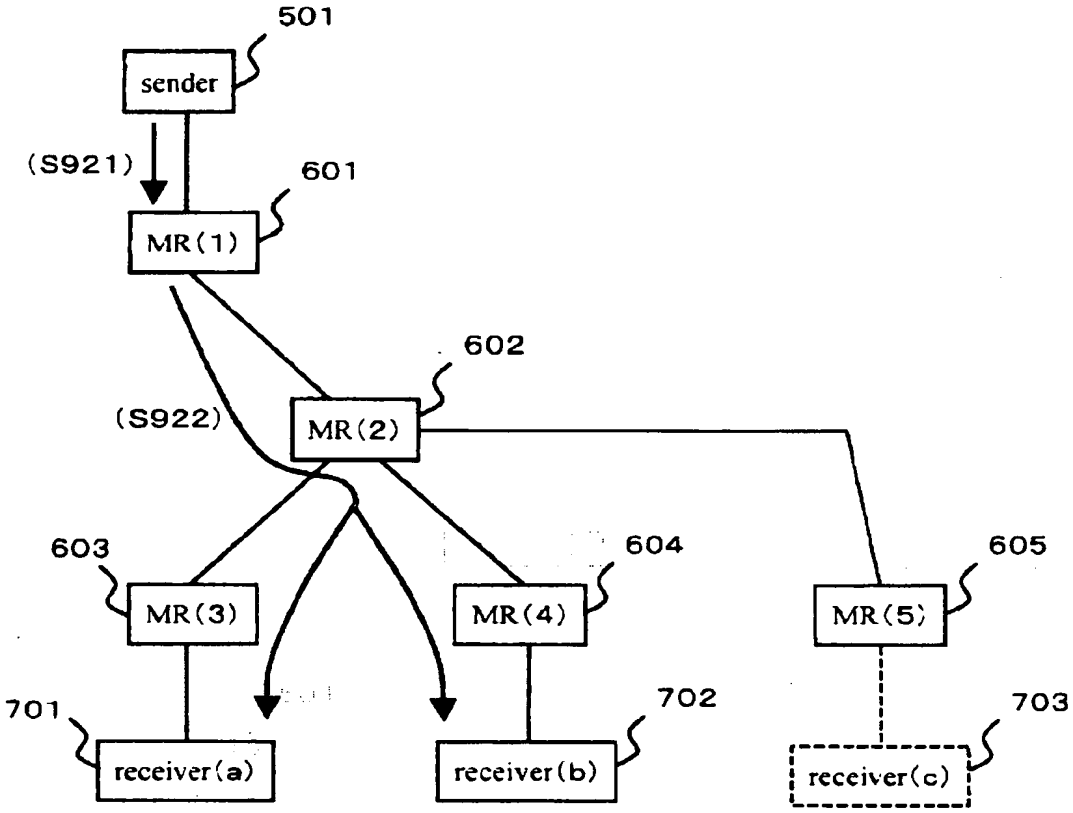
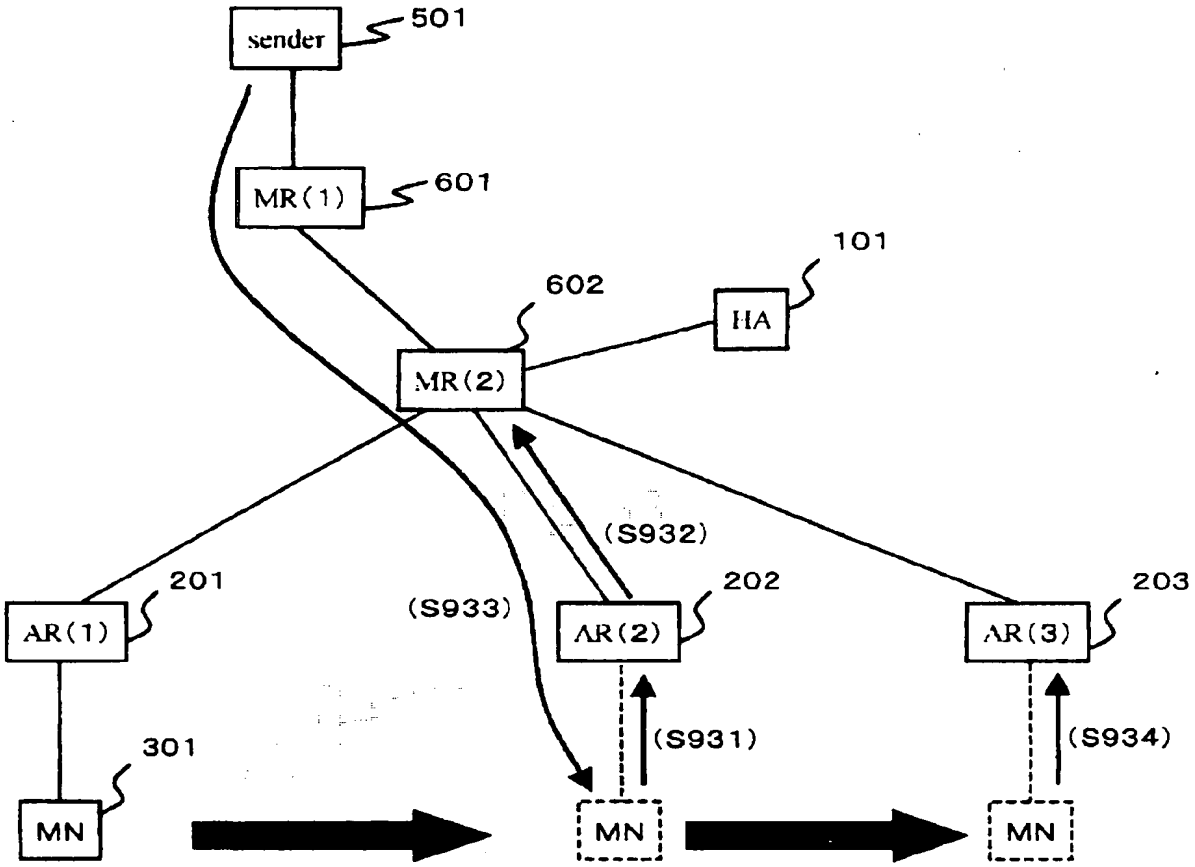

501
sender
(S921)
601
MR(1)
602
(S922)
MR(2)
603
MR(3)
604
MR(4)
605
MR(5)
701
receiver(a)
702
receiver(b)
703
receiver(c)

Fig. 33


sender
501
MR(1)
601
101
602
HA
MR(2)
(S932)
201
(S933)
202
203
AR(1)
AR(2)
AR(3)
(S931)
(S934)
301
MN
MN
MN